Verification of Odor Dispersion Modeling for Siting of Livestock and Poultry Production Facilities

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Collaborative Effort

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Project Objectives

1. Compare and standardize <u>ambient</u> level odor measurement methods from livestock and poultry production systems for evaluation of atmospheric dispersion models for odor.

2. Incorporate existing odor dispersion modeling techniques into one consistent tool capable of handling multiple sources in a community of multiple receptors, and incorporating localized weather patterns, terrain, production size, and manure management techniques.

3. Disseminate the knowledge and use of a standardized ambient level odor footprint tool and odor dispersion characteristics to stakeholders.

Community Odor Concentrations

What is the best way to measure odor strength? Can various techniques be correlated with each other?

How do odors travel? How far? When is the potential greatest for odor nuisance?

How can this information be used to make siting recommendations?

Purpose of Study

Develop a tool that can be used to assess
odor impact of a proposed animal facility on receptors in a
community

Progress to Date

1. ISU Nasal Ranger "pool" selected and trained
(February-March 2004)

2. UMN Intensity sniffers and ISU Nasal Rangers participated
in three controlled-chamber calibration sessions using ISU's Air Dispersion Laboratory
(March-May 2004)

3. Three intensive field sessions conducted at an Iowa emission site
for collection of odor model validation data
(June, July, November 2004)

4.   Within these three intensive field sessions, 13 specific stability events monitored

5. Data organized and currently being processed for model validation

Work in Progress

AERMOD being evaluated for odor dispersion modeling

CALPUFF being evaluated for odor dispersion modeling

Existing models currently used for siting based on odor being evaluated
(UMN's OFFSET and ISU's CAM)

Procedures

Calibrating Ambient-Level Odor Measurement Methods

The Situation: Odor measurements are subjective to a certain degree. Methods proposed to quantify odor include:

a. Using H_2S concentration
b. Using scentometry (Barneby-Sutcliffe, Nasal Ranger, etc.)
c. Using intensity (0-5 scale as an example)
d. Using bag samples with dynamic-dilution olfactometry

For Modeling: Need to be able to calibrate a model with an appropriate measurement method and then be able to relate back to the other methods.

Controlled Chamber Calibration Procedures

Air Dispersion Laboratory (ADL) used to disperse swine odor into a controlled environment
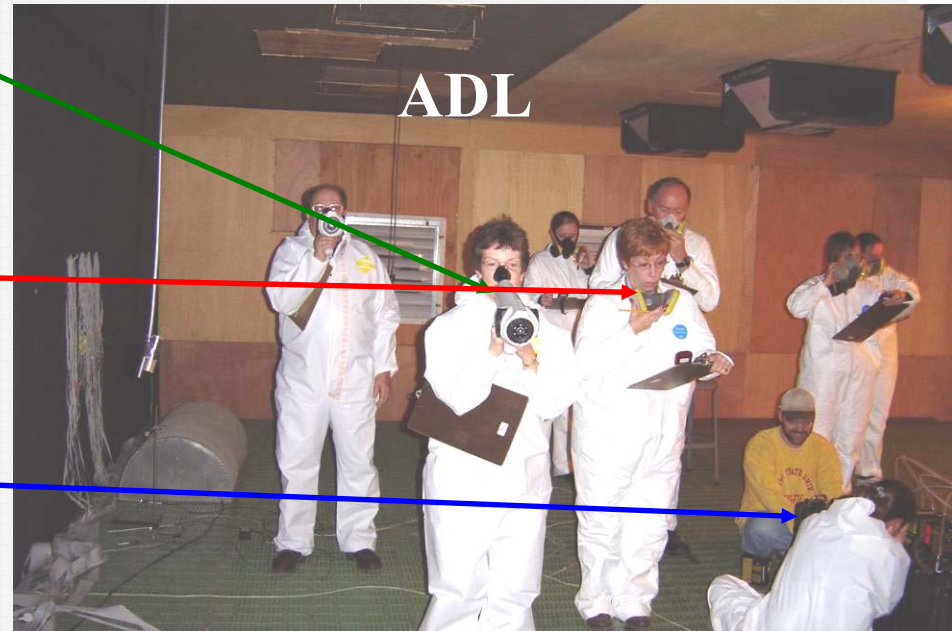

Nasal Ranger

vs

Intensity

vs

Olfactometry

ADL

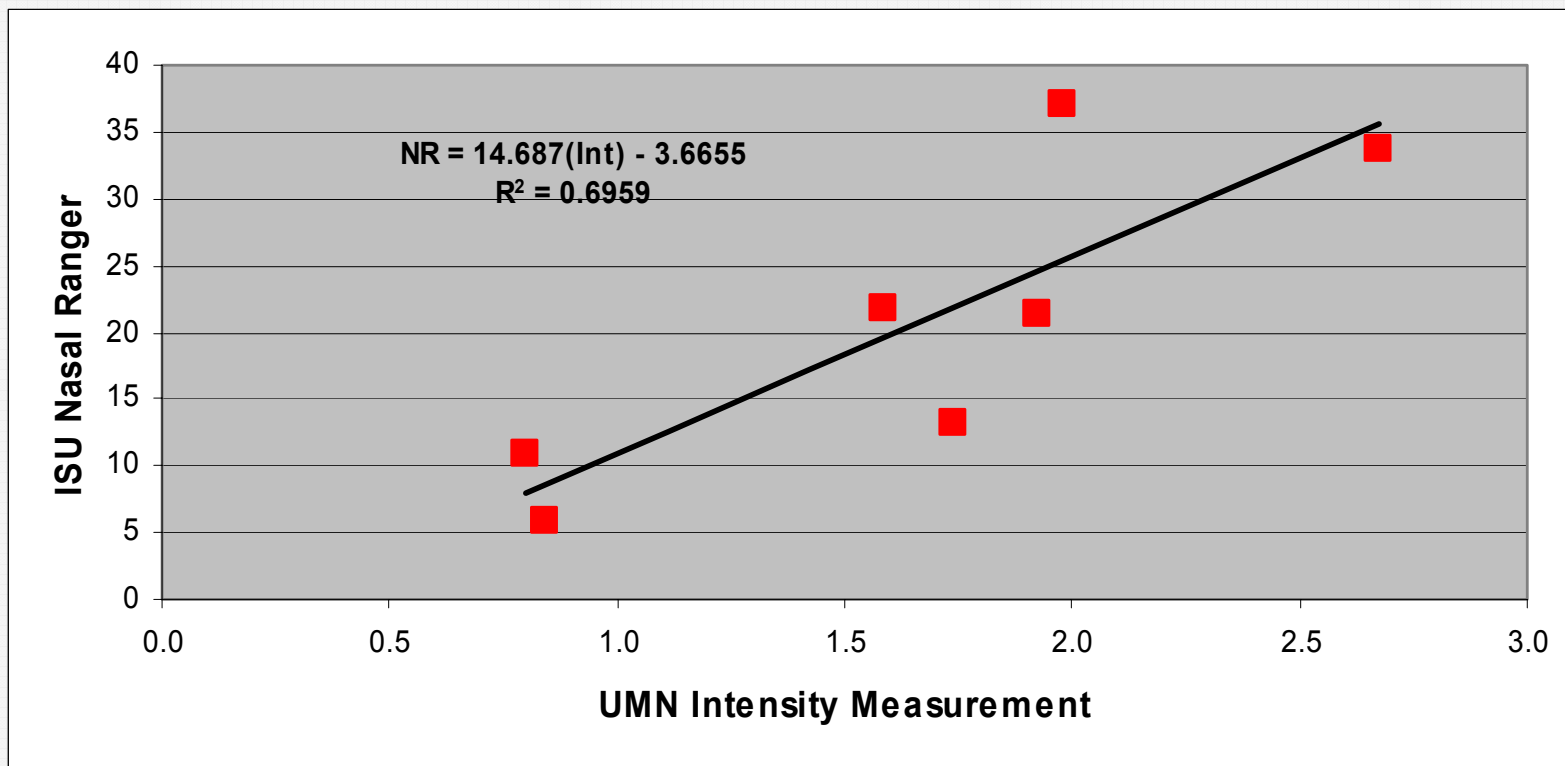# Odor Strength Measurements

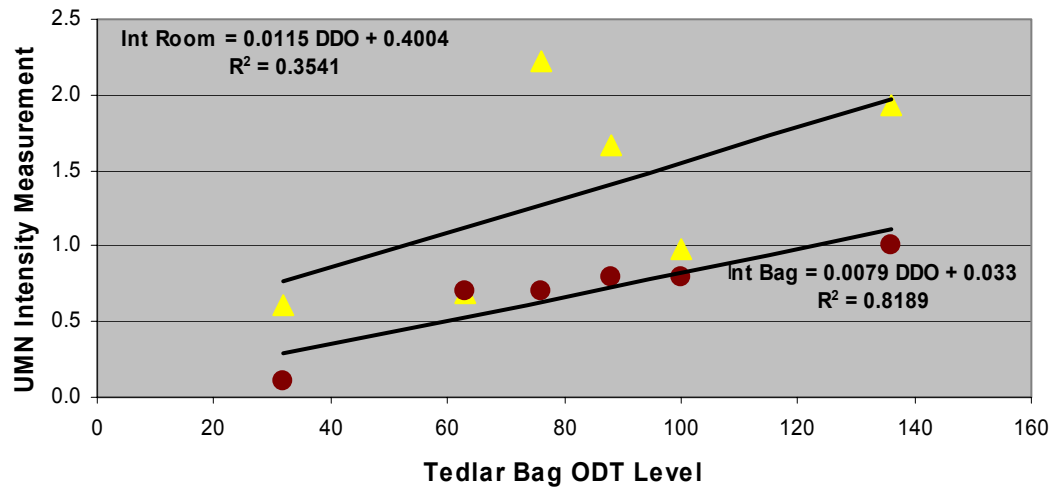**St. Croix Sensory Dynamic-Dilution Olfactometer**

(ISU and UMN Labs used)

Example Results from Controlled Chamber

Air Dispersion Laboratory (ADL) used to disperse swine odor into a controlled environment
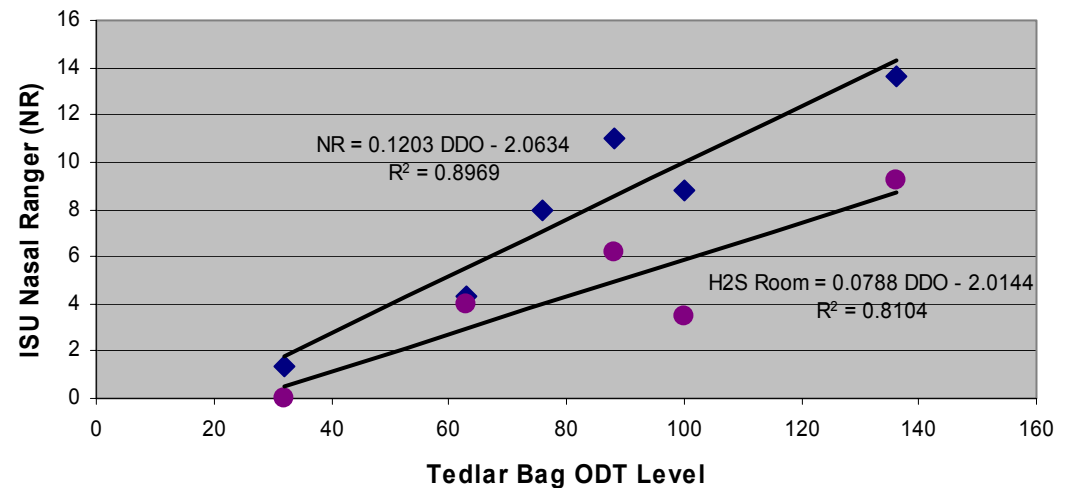

NR = 14.687(Int) - 3.6655
R^2 = 0.6959

ISU Nasal Ranger

UMN Intensity Measurement

Example Results from Controlled Chamber

Int Room = 0.0115 DDO + 0.4004
R^2 = 0.3541

Int Bag = 0.0079 DDO + 0.033
R^2 = 0.8189

UMN Intensity Measurement

Tedlar Bag ODT Level

Compares UMN Intensity with Tedlar bag sampling and subsequent analysis via dynamic dilution olfactometry

NR = 0.1203 DDO - 2.0634
R^2 = 0.8969

H2S Room = 0.0788 DDO - 2.0144
R^2 = 0.8104

ISU Nasal Ranger (NR)

Tedlar Bag ODT Level

Compares ISU Nasal Ranger and chamber H_2S concentrations (ppb) with Tedlar bag sampling and subsequent analysis via dynamic dilution olfactometry

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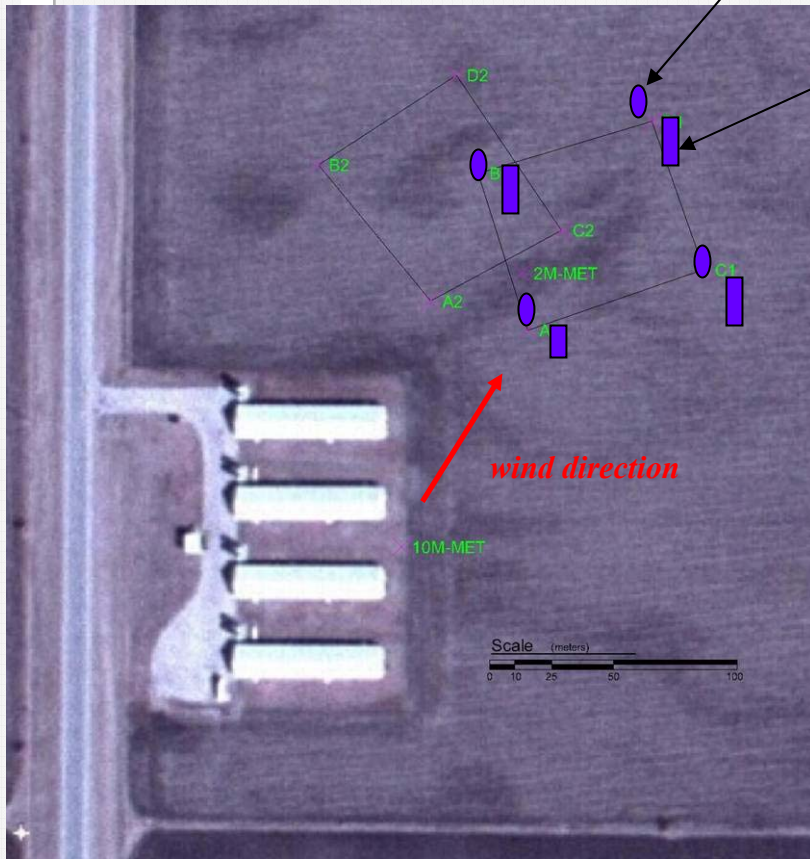
Field Sampling Layout and Procedures

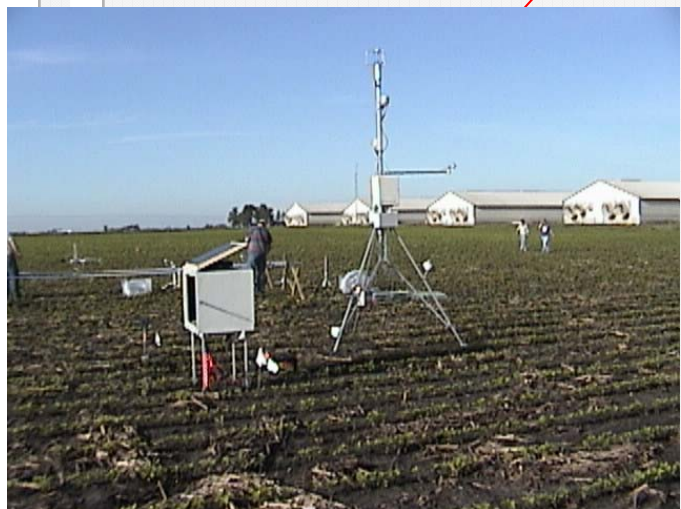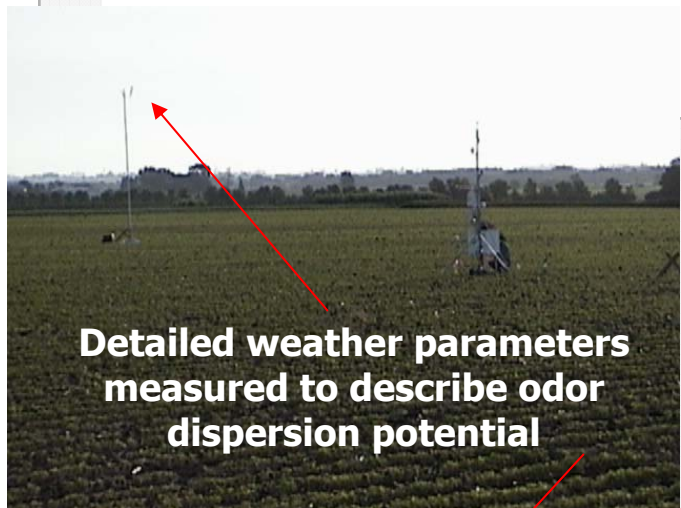ISU Nasal Rangers (NR)

UMN Intensity Sniffers (Int)

Located in and around the odor plume at selected distances downwind

Collect field odor data for use in calibrating odor dispersion models (EPA's AERMOD, ISU's CAM, UMN's OFFSET)

Field Sampling Events
Very Intense Two-Day Procedure Involving Three Universities and Roughly 40 People

Detailed weather parameters measured to describe odor dispersion potential

Simultaneous odor collection using the various techniques described

Simultaneous barn odor emission measured
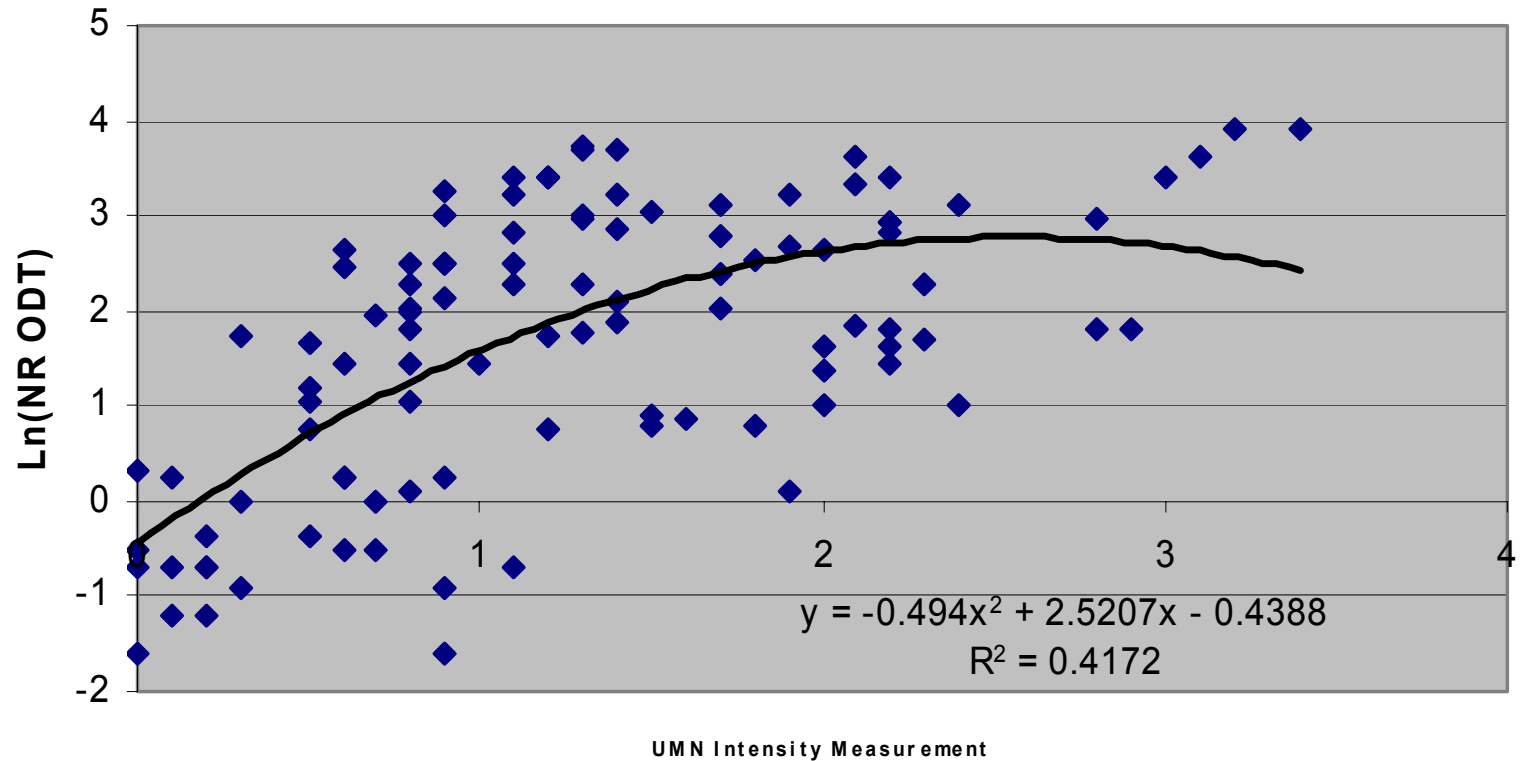
Field Data Collected from Emission Site

4-Barn 1,000-hd/barn Site Monitored for Emissions
(USDA-IFAFS APECAB Project)

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Field Data Results

ISU Nasal Ranger vs UMN Intensity

$$y = -0.494x^2 + 2.5207x - 0.4388$$
$$R^2 = 0.4172$$

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Field Data Results and Dispersion

The collected field data was grouped by stability class as defined by Pasquill-Gifford.

The following two graphs show preliminary findings for the dispersion of odors and hydrogen sulfide as a function of atmospheric stability.

Unstable atmospheres grouped as stability classes A to C. Stable atmospheres grouped as stability classes D to F.
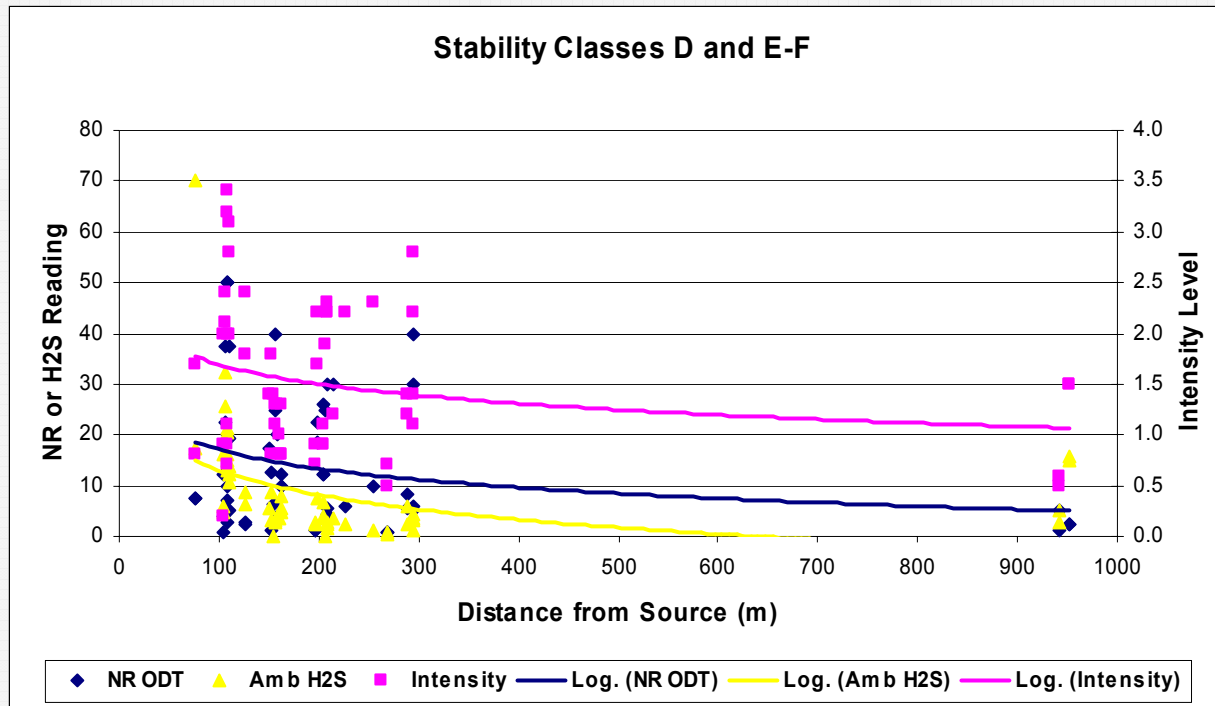
Field Data Odor Dispersion

Odor Dispersion: Unstable Atmospheres

Stability Classes A thru C

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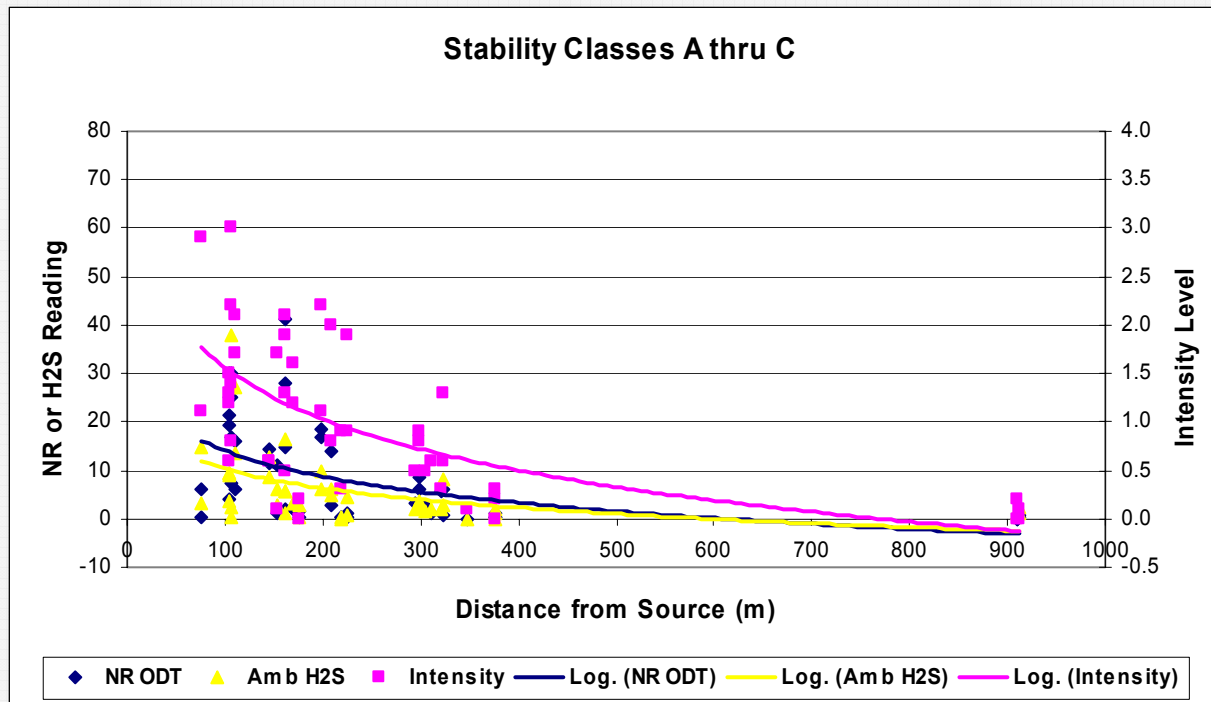
Field Data Odor Dispersion

Odor Dispersion: Stable Atmospheres

Stability Classes D and E-F

Project Summary

Controlled chamber and field sampling of odor dispersion completed. Correlations will be summarized between measurement methods. Will allow for odor measurement methods to "talk" with each other.

Wide range of atmospheric conditions monitored. Data set will provide a framework from which to calibrate models for odor dispersion. The variability encountered was large but not unexpected. Highlights the need for models that consider averaged historical data over time.

Thank You

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